



January 25, 2023

Madison Johnson
Seaborn Pile Driving
1080 West Ewing Street
Seattle, Washington 98119

**RE: Bulkhead Recommendations
Chen Residence
8440 Benotho Place
Mercer Island, Washington 98040
RGI Project No. 2022-709-1**

Dear Madison Johnson:

The Riley Group, Inc. (RGI) is pleased to present our recommendations for applying a permit for repairing a bulkhead at the above-referenced site. On December 13, 2022, RGI observed the site condition and performed subsurface exploration by advancing three borings using a hand auger in the existing retaining wall and proposed bulkhead area. The boring locations are shown on Figure 2. The following presents our findings of the soil conditions and recommendations for the proposed project based on referenced report and document.

PROJECT DESCRIPTION

RGI understands that the owner plans to replace existing wood bulkhead, about 116 feet long and about 5 feet tall, with granite rock bulkhead. A geotechnical engineering report (GER) will be needed for the project. Our understanding of the project is based on site plans prepared by the Client, Seaborn Pile Driving dated December 2, 2022.

An RGI geologist visited the site on December 13, 2022 and observed the existing shoreline condition. Based on our observations, the project is feasible from a geotechnical standpoint.

Currently, the bulkhead is the only structure to protect the site from being damaged by wave action. Per City of Mercer Island Municipal Codes 19.13.050(B), we recommend that the bulkhead be repaired to protect the property from being damaged by wave action from Lake Washington.

SOIL AND GROUNDWATER CONDITION

The soils encountered during field exploration include up to 2.5 feet of fill comprised of soft to medium stiff silt with some sand over medium stiff elastic silt with some sand and loose to medium dense silty sand with gravel and gravelly sand with trace silt. A water table was encountered at 3 feet in Hand Auger HA-1. More detailed descriptions of the subsurface conditions encountered are presented in the attached logs. Sieve analysis was performed on one selected soil sample. The grain size distribution curve is included.

At the time of the field exploration was performed, the lake level is 2.5 to 3 feet below the top of the existing bulkhead. RGI understands that the lake level variates about 2 feet and will be lower in the winter.

GEOTECHNICAL RECOMMENDATIONS

Analysis

The existing bulkhead is supporting the slope above the shoreline. The existing bulkhead is in need of repair. If it is not repaired properly, the slope will be affected by erosion caused by wave action.

RGI reviewed a wave climate report in Lake Washington prepared by Mott McDonald dated September 2015, the report is for entire Lake Washington including wave information for Mercer Island. Based on the report, the largest significant waves occur at the shoreline facing south and southwest along Mercer Island in Lake Washington. The project area is facing southeast and the wave height at the bulkhead area is 2 to 3 feet with a peak period of 2 to 3 seconds and wave energy of up to 50 lbs-foot per square foot. With the expected wave height, peak period, and energy, we expect that the shoreline, without protection from a bulkhead, will have an erosion rate from several inches to a foot per year. The toe of slope will be completely eroded within the next three years. The slope stability will be affected and a landslide will likely occur in the affected area.

The bulkhead is the only structure that protects the slope from being damaged by wave action. Per City of Mercer Island Municipal Codes 19.13.050(B), we recommend that the existing bulkhead be repaired as soon as possible to protect the property from being damaged by wave action from Lake Washington.

Based on the current scope of work, an existing rock bulkhead will be repaired to match the existing condition. Some of the rock blocks will be reused. We recommend that the height of the bulkhead be at least 3 feet higher than the maximum wave height which is 2 to 3 feet. The new bulkhead will be at least 3 feet above the Ordinary High Water Mark (OHWM). Our geotechnical comments and recommendations concerning the design and construction of the replacement bulkhead are provided below.

Rock Bulkhead

Rock bulkhead is a rockery used to protect waterfront property, and it is not intended to function as an engineered structure to resist lateral earth pressures as a retaining wall. The primary function of a rock bulkhead is to provide stability and erosion control due to wave action. The amount of support obtained will depend on a large extent on the quality of the workmanship, size, shape of the rocks used, and drainage behind it. A critical factor in rockery construction is the quality of the rock material used. Rock for use in rockery should be cubical, rectangular, or tubular in shape with the longest dimension not exceeding three times the width. The rocks recycled from existing bulkhead may not be used if not meeting the requirement. Additional rocks may need to be imported. The rock bulkhead should be constructed by an experienced rockery contractor in accordance with Associated Rockery Contractors (ARC) guidelines.

We recommended that limiting the rockery height to eight feet placed along the native dense soil. A general rock bulkhead section detail is included on Figure 3.

The following sections of the report provide general recommendations related to piles, erosion and sediment control, excavations, structural fill, and backfill compaction.

Erosion and Sediment Control

Potential sources or causes of erosion and sedimentation depend on construction methods, slope length and gradient, amount of soil exposed and/or disturbed, soil type, construction sequencing

and weather. The impacts on erosion-prone areas can be reduced by implementing an erosion and sedimentation control plan. The plan should be designed in accordance with applicable city and/or county standards.

RGI recommends the following erosion control Best Management Practices (BMPs):

- Scheduling site preparation and grading for the drier summer and early fall months and undertaking activities that expose soil during periods of little or no rainfall
- Establishing a quarry spall construction entrance
- Installing siltation control fencing or anchored straw or coir wattles on the downhill side of work areas
- Covering soil stockpiles with anchored plastic sheeting
- Revegetating or mulching exposed soils with a minimum 3-inch thickness of straw if surfaces will be left undisturbed for more than one day during wet weather or one week in dry weather
- Directing runoff away from exposed soils and slopes
- Minimizing the length and steepness of slopes with exposed soils and cover excavation surfaces with anchored plastic sheeting (Graded and disturbed slopes should be tracked in place with the equipment running perpendicular to the slope contours so that the track marks provide a texture to help resist erosion and channeling. Some sloughing and raveling of slopes with exposed or disturbed soil should be expected.)
- Decreasing runoff velocities with check dams, straw bales or coir wattles
- Confining sediment to the project site
- Inspecting and maintaining erosion and sediment control measures frequently (The contractor should be aware that inspection and maintenance of erosion control BMPs is critical toward their satisfactory performance. Repair and/or replacement of dysfunctional erosion control elements should be anticipated.)

Permanent erosion protection should be provided by reestablishing vegetation using hydroseeding and/or landscape planting. Until the permanent erosion protection is established, site monitoring should be performed by qualified personnel to evaluate the effectiveness of the erosion control measures. Provisions for modifications to the erosion control system based on monitoring observations should be included in the erosion and sedimentation control plan.

Excavations

All temporary cut slopes associated with the site and utility excavations should be adequately inclined to prevent sloughing and collapse. Based on OSHA regulations, the native soil classifies as a Group B soil. Accordingly, for excavations more than 4 feet but less than 20 feet in depth, the temporary side slopes should be laid back with a minimum slope inclination of 1-1/2H:1V (Horizontal:Vertical).

In all cases, however, appropriate inclinations will depend on the actual soil and groundwater conditions encountered during earthwork. Ultimately, the site contractor must be responsible for maintaining safe excavation slopes that comply with applicable OSHA or WISHA guidelines.

Structural Fill

The native soil encountered is suitable for re-use as structural fill if the moisture can be properly controlled. If the construction occurs in wet weather, RGI recommends import structural fill be used for all grading and backfill. The import material must meet the grading requirements listed in Table 2 in order to be used as structural fill.

Table 2 Structural Fill Gradation

U.S. Sieve Size	Percent Passing
3 inches	100
No. 4 sieve	75 percent
No. 200 sieve	5 percent *

*Based on minus 3/4 inch fraction.

Prior to use, an RGI representative should observe and test all materials imported to the site for use as structural fill. Structural fill materials should be placed in uniform loose layers not exceeding 12 inches and compacted as specified in Table 3. The soil's maximum density and optimum moisture should be determined by American Society of Testing and Materials D1557-09 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (ASTM D1557).

Table 3 Structural Fill Compaction ASTM D1557

Location	Material Type	Minimum Compaction Percentage	Moisture Content Range	
Foundations	On-site granular or approved imported fill soils:	95	+2	-2
Retaining Wall Backfill	On-site granular or approved imported fill soils:	92	+2	-2

Placement and compaction of structural fill should be observed by RGI. A representative number of in-place density tests should be performed as the fill is being placed to confirm that the recommended level of compaction is achieved.

ADDITIONAL SERVICES

RGI is available to provide further geotechnical consultation throughout the design phase of the project. RGI should review the final design and specifications in order to verify that earthwork and foundation recommendations have been properly interpreted and incorporated into project design and construction.

RGI is also available to provide geotechnical engineering and construction monitoring services during construction. The integrity of the earthwork and construction depends on proper site preparation and procedures. In addition, engineering decisions may arise in the field in the event

that variations in subsurface conditions become apparent. Construction monitoring services are not part of this scope of work. If these services are desired, please let us know and we will prepare a cost proposal.

LIMITATIONS

This letter is the property of RGI, Seaborn Pile Driving, and its designated agents. Within the limits of the scope and budget, this letter was prepared in accordance with generally accepted geotechnical engineering practices in the area at the time this letter was issued. This letter is intended for specific application to the Chen Residence project in Mercer Island, Washington, and for the exclusive use of Seaborn Pile Driving and its authorized representatives. No other warranty, expressed or implied, is made. Site safety, excavation support, and dewatering requirements are the responsibility of others.

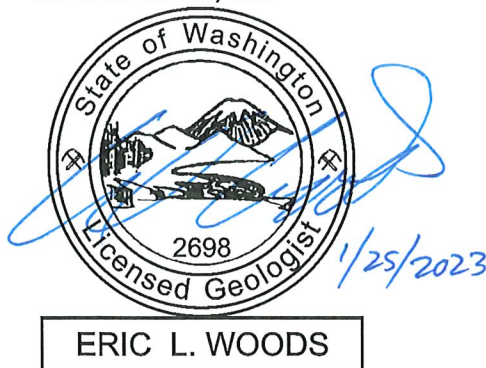
The scope of services for this project does not include either specifically or by implication any environmental or biological (for example, mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, we can provide a proposal for these services.

The analyses and recommendations presented in this letter are based upon data obtained from reviewing the explorations completed by others on the site. Variations in soil conditions can occur, the nature and extent of which may not become evident until construction. If variations appear evident, RGI should be requested to reevaluate the recommendations in this letter prior to proceeding with construction.

We trust the information presented is sufficient for your current needs. If you have any questions regarding this letter report or require additional information, please call us at (425) 415-0551.

Sincerely yours,

THE RILEY GROUP, INC.



Eric L. Woods, LG
Project Geologist



Ricky R. Wang, PhD, PE
Principal Engineer

- Attachments:
- Figure 1 Site Vicinity Map
 - Figure 2 Geotechnical Exploration Plan
 - Figure 3 Typical Rock Bulkhead Section
 - Hand Auger Boring Logs and Grainsize Analysis



USGS, 2020, Mercer Island, Washington
7.5-Minute Quadrangle

Approximate Scale: 1"=1000'



Corporate Office
17522 Bothell Way Northeast
Bothell, Washington 98011
Phone: 425.415.0551
Fax: 425.415.0311

Chen Bulkhead
RGI Project Number:
2022-709-1

Figure 1
Site Vicinity Map

Date Drawn:
12/2022

Address: 8440 Benotho Place, Mercer Island, Washington 98040

SUBJECT PROPERTY:
 8440 Benotho Place
 Parcel #: 073610-0100

EXISTING SEWER LOCATION,
 FIELD VERIFIED (SS-GM-00143)

B-1

EXISTING BOAT
 LIFT NO WORK

B-2

PROPOSED GRANITE ROCK BULKHEAD

OHWM -21.8'
 (CORPS DATUM)

EXISTING PIER NO WORK

PROPERTY LINE

B-3

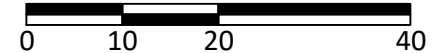
87'-2" TO /
 NEIGHBORING
 DOCK /

GARY+MITZI
 NOTHO PL 98040

I AKF WAS

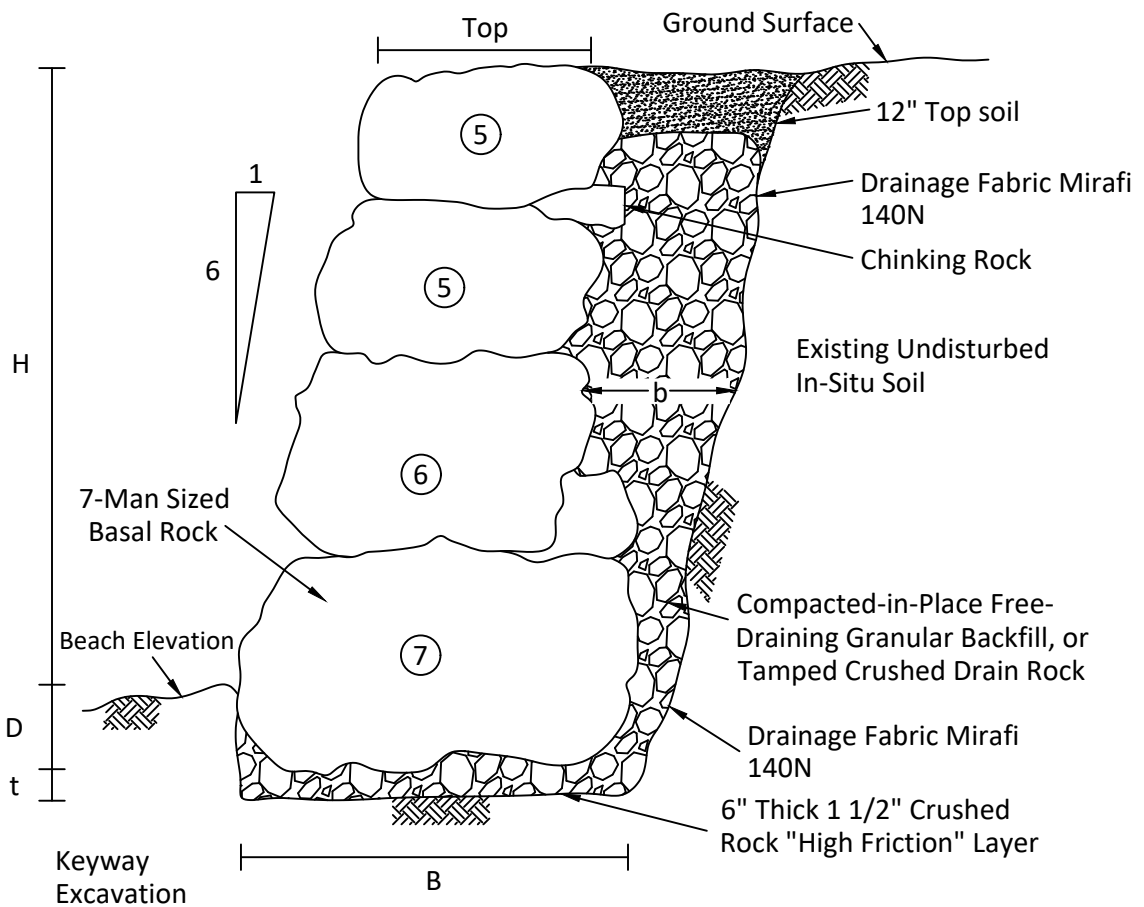
⊕ = Boring by RGI, 12/13/22
 - - - = Site boundary

Approximate Scale: 1"=20'



Corporate Office
 17522 Bothell Way Northeast
 Bothell, Washington 98011
 Phone: 425.415.0551
 Fax: 425.415.0311

Chen Bulkhead		Figure 2
RGI Project Number: 2022-709-1	Geotechnical Exploration Plan	Date Drawn: 12/2022
Address: 8440 Benotho Place, Mercer Island, Washington 98040		



LEGEND

- Maximum estimated free-standing rock wall height, H = 12 feet
- Minimum estimated keyway excavation depth, D = 2-1/2 feet
- Minimum recommended thickness of 1-1/2" crushed rock "high friction" - layer t = 6 inches
- Minimum estimated total rock wall length, H+D-I = 13-1/2 feet
- Minimum recommended width of keyway excavation, B = See Table
- Minimum recommended thickness of drain rock layer, b = 1 foot
- Allowable soil bearing capacity of base of rock wall = 2,100 psf
- Minimum recommended basal rock size = 7-man
- Minimum recommended size of chinking rock = 2-man
- Neglect upper 1 foot of passive resistance in design
- Rock bulkhead wall construction to be in general accordance with the geotechnical engineering report and the ARC Rockery Construction Guidelines

Rock Man-Size	Rock Dimensions (Inches)	Rock Weight (Pounds)
3-man	28-36	700-2,000
4-man	36-48	2,000-4,000
5-man	48-54	4,000-6,000
6-man	54-60	6,000-8,000
7-man	>60	>8,000

H (Feet)	B (Feet)	Top (Feet)
4	4	3
6	5.5	4
8	7	5.5
10	8.5	6
12	9.5	7



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Chen Bulkhead		Figure 3
RGI Project Number: 2022-709-1	Typical Rock Bulkhead Section	Date Drawn: 12/2022
Address: 8440 Benotho Place, Mercer Island, Washington 98040		

Project Name: **Chen Bulkhead**
 Project Number: **2022-709-1**
 Client: **Seaborn Oile Driving**



Hand Auger No.: **HA-1**
 Sheet 1 of 1

Date(s) Drilled: 12/13/2022	Logged By: ELW	Surface Conditions: Gravel
Drilling Method(s): Hand Auger	Drill Bit Size/Type: N/A	Total Depth of Borehole: 4 feet bgs
Drill Rig Type: N/A	Drilling Contractor: N/A	Approximate Surface Elevation: N/A
Groundwater Level: 3'	Sampling Method(s): Auger	Hammer Data : N/A
Borehole Backfill: Cuttings	Location: 8440 Benotho Place, Mercer Island, Washington	

Elevation (feet)	Depth (feet)	Sample Type	Sample ID	Sampling Resistance, blows/ft	Recovery (%)	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	Moisture (%)
0						Fill		2" 5/8" minus crushed rock	
								2" grass and topsoil	
						Fill		Brown SILT with some sand, soft, moist to wet (Fill)	
									24
						SM		Gray silty SAND with some gravel, loose to medium dense, wet Contains wood debris	56
						SP		Gray gravelly SAND with trace silt, medium dense, water bearing 3% fines	13
								Hand Auger terminated at 4' due to caving.	
5									

Project Name: **Chen Bulkhead**
 Project Number: **2022-709-1**
 Client: **Seaborn Oile Driving**



Hand Auger No.: **HA-2**
 Sheet 1 of 1

Date(s) Drilled: 12/13/2022	Logged By: ELW	Surface Conditions: Gravel
Drilling Method(s): Hand Auger	Drill Bit Size/Type: N/A	Total Depth of Borehole: 3 feet bgs
Drill Rig Type: N/A	Drilling Contractor: N/A	Approximate Surface Elevation: N/A
Groundwater Level: Not Encountered	Sampling Method(s): Auger	Hammer Data : N/A
Borehole Backfill: Cuttings	Location: 8440 Benotho Place, Mercer Island, Washington	

Elevation (feet)	Depth (feet)	Sample Type	Sample ID	Sampling Resistance, blows/ft	Recovery (%)	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	Moisture (%)
0						Fill		3" 5/8" minus crushed rock	
								2" grass and topsoil	
						Fill		Brown SILT with some sand, soft to medium stiff, moist to wet (Fill)	
						MH		Tan Elastic SILT with some sand, medium stiff, moist	26
								Hand Auger terminated at 3' due to log obstruction.	
5									

Project Name: **Chen Bulkhead**
 Project Number: **2022-709-1**
 Client: **Seaborn Oile Driving**



Hand Auger No.: **HA-3**
 Sheet 1 of 1

Date(s) Drilled: 12/13/2022	Logged By: ELW	Surface Conditions: Gravel
Drilling Method(s): Hand Auger	Drill Bit Size/Type: N/A	Total Depth of Borehole: 1.5 feet bgs
Drill Rig Type: N/A	Drilling Contractor: N/A	Approximate Surface Elevation: N/A
Groundwater Level: Not Encountered	Sampling Method(s):	Hammer Data : N/A
Borehole Backfill: Cuttings	Location: 8440 Benotho Place, Mercer Island, Washington	

Elevation (feet)	Depth (feet)	Sample Type	Sample ID	Sampling Resistance, blows/ft	Recovery (%)	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	Moisture (%)
0						Fill		2" 5/8" minus crushed rock	
								2" grass and topsoil	
						Fill		Brown SILT with some sand, soft, moist to wet (Fill)	
								Hand Auger terminated at 1.5' due to log obstruction.	
5									

Project Name: **Chen Bulkhead**

Project Number: **2022-709-1**

Client: **Seaborn Oile Driving**



Key to Log of Boring
Sheet 1 of 1

Elevation (feet)	Depth (feet)	Sample Type	Sample ID	Sampling Resistance, blows/ft	Recovery (%)	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	Moisture (%)
1	2	3	4	5	6	7	8	9	10





COLUMN DESCRIPTIONS

- 1** Elevation (feet): Elevation (MSL, feet).
- 2** Depth (feet): Depth in feet below the ground surface.
- 3** Sample Type: Type of soil sample collected at the depth interval shown.
- 4** Sample ID: Sample identification number.
- 5** Sampling Resistance, blows/ft: Number of blows to advance driven sampler one foot (or distance shown) beyond seating interval using the hammer identified on the boring log.
- 6** Recovery (%): Core Recovery Percentage is determined based on a ratio of the length of core sample recovered compared to the cored interval length.
- 7** USCS Symbol: USCS symbol of the subsurface material.
- 8** Graphic Log: Graphic depiction of the subsurface material encountered.
- 9** MATERIAL DESCRIPTION: Description of material encountered. May include consistency, moisture, color, and other descriptive text.
- 10** Moisture (%): Moisture, expressed as a water content.







FIELD AND LABORATORY TEST ABBREVIATIONS




- CHEM: Chemical tests to assess corrosivity
- COMP: Compaction test
- CONS: One-dimensional consolidation test
- LL: Liquid Limit, percent
- PI: Plasticity Index, percent
- SA: Sieve analysis (percent passing No. 200 Sieve)
- UC: Unconfined compressive strength test, Qu, in ksf
- WA: Wash sieve (percent passing No. 200 Sieve)

MATERIAL GRAPHIC SYMBOLS






-  AF
-  SILT, SILT w/SAND, SANDY SILT (MH)
-  Silty SAND (SM)
-  Poorly graded SAND (SP)

TYPICAL SAMPLER GRAPHIC SYMBOLS

-  Auger sampler
-  Bulk Sample
-  3-inch-OD California w/ brass rings
-  CME Sampler
-  Grab Sample
-  2.5-inch-OD Modified California w/ brass liners

-  Pitcher Sample
-  2-inch-OD unlined split spoon (SPT)
-  Shelby Tube (Thin-walled, fixed head)

OTHER GRAPHIC SYMBOLS

-  Water level (at time of drilling, ATD)
-  Water level (after waiting, AW)
-  Minor change in material properties within a stratum
-  Inferred/gradational contact between strata
-  Queried contact between strata

GENERAL NOTES

- 1: Soil classifications are based on the Unified Soil Classification System. Descriptions and stratum lines are interpretive, and actual lithologic changes may be gradual. Field descriptions may have been modified to reflect results of lab tests.
- 2: Descriptions on these logs apply only at the specific boring locations and at the time the borings were advanced. They are not warranted to be representative of subsurface conditions at other locations or times.

GRAIN SIZE ANALYSIS
ASTM D421, D422, D1140, D2487, D6913

PROJECT TITLE	Chen Bulkhead	Exploration Type	HA-1
PROJECT NO.	2022-709-1	Depth	3'
TECH/TEST DATE	PL/CC 12/14/2022	Date Received	12/13/2022

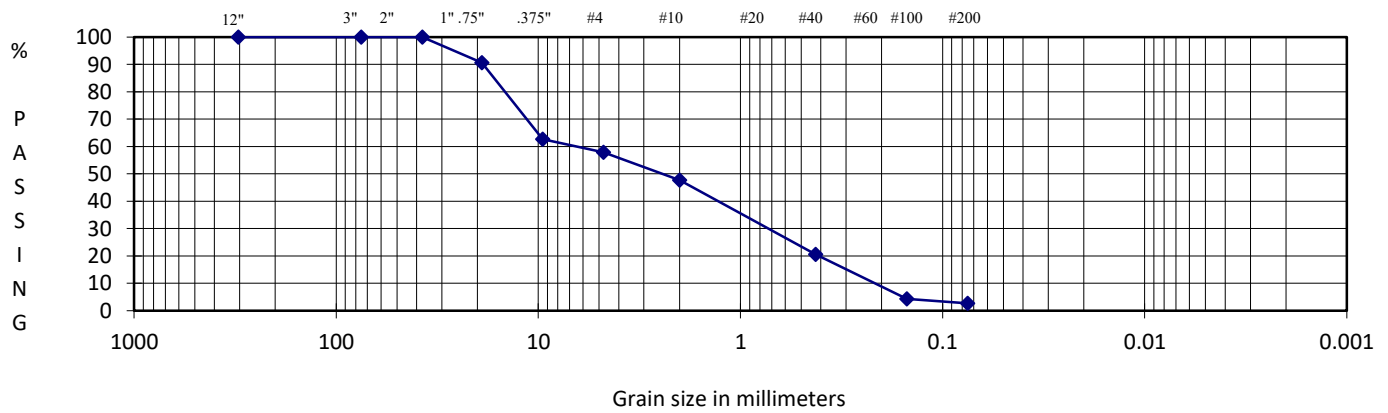
WATER CONTENT (Delivered Moisture)		Total Weight Of Sample Used For Sieve Corrected For Hygroscopic Moisture	
Wt Wet Soil & Tare (gm)	(w1) 604.1	Weight Of Sample (gm)	534.9
Wt Dry Soil & Tare (gm)	(w2) 534.9	Tare Weight (gm)	16.0
Weight of Tare (gm)	(w3) 16.0	(W6) Total Dry Weight (gm)	518.9

Weight of Water (gm)	(w4=w1-w2) 69.2	SIEVE ANALYSIS		
Weight of Dry Soil (gm)	(w5=w2-w3) 518.9	Wt Ret	(Wt-Tare)	Cumulative
Moisture Content (%)	(w4/w5)*100 13	+Tare		(%Retained)
				(wt ret/w6)*100
				% PASS
				(100-%ret)

% COBBLES	0.0
% C GRAVEL	9.4
% F GRAVEL	32.7
% C SAND	10.2
% M SAND	27.2
% F SAND	17.8
% FINES	2.7
% TOTAL	100.0

D10 (mm)	0.21
D30 (mm)	0.7
D60 (mm)	7
Cu	33.3
Cc	0.3

	Wt Ret +Tare	(Wt-Tare)	Cumulative (%Retained) (wt ret/w6)*100	% PASS (100-%ret)	
12.0"	16.0	0.00	0.00	100.00	cobbles
3.0"	16.0	0.00	0.00	100.00	coarse gravel
2.5"					coarse gravel
2.0"					coarse gravel
1.5"	16.0	0.00	0.00	100.00	coarse gravel
1.0"					coarse gravel
0.75"	64.7	48.70	9.39	90.61	fine gravel
0.50"					fine gravel
0.375"	209.5	193.50	37.29	62.71	fine gravel
#4	234.3	218.30	42.07	57.93	coarse sand
#10	287.4	271.40	52.30	47.70	medium sand
#20					medium sand
#40	428.3	412.30	79.46	20.54	fine sand
#60					fine sand
#100	512.2	496.20	95.63	4.37	fine sand
#200	520.9	504.90	97.30	2.70	finer
PAN	534.9	518.90	100.00	0.00	silt/clay



DESCRIPTION Gravelly SAND with trace silt

USCS SP

Prepared For:
Seaborn Pile Driving

Reviewed By:
ELW

